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A DEVONIAN OUTLIER NEAR THE CREST OF THE OZARK UPLIFT

JOSIAH BRIDGE AND B. E. CHARLES
Missouri School of Mines, Rolla, Missouri

INTRODUCTION

The Paleozoic history of the Ozark Uplift constitutes an extremely interesting stratigraphic study, and one upon which comparatively little has been written. The earlier stages of this history, up to the close of the Canadian epoch, are fairly well known, for rocks belonging to this and the preceding epochs are well exposed throughout the uplift. Of the later history but little is known, for so thoroughly have the subsequent periods of erosion performed their work, that only small and widely separated outliers of the younger formations remain on the higher parts of the uplift. Around the borders of this dome are belts of younger formations, more or less completely encircling it, and it has always been a question as to how far these formations once extended toward the crest of the structure and which of them, if any, completely covered it. Upon this question no two sets of paleogeographic maps agree. One of the chief reasons for this disagreement is lack of information concerning the region, for, as a whole, there has been little detailed stratigraphic work done in the region of the Ozark Uplift.

In the area around Rolla (110 miles southwest of St. Louis and well toward the crest of the uplift) the existence of outliers of Pennsylvanian and Mississippian age has long been known. The former consist of stratified deposits of sandstone and shale, and cover far greater areas than are shown on existing maps.¹ The Mississippian outliers are, for the most part, small areas covered with fossiliferous, residual boulders,² which have apparently weath-

¹ The new geological map of Missouri, now in press, shows many of the larger Pennsylvanian outliers.

² Josiah Bridge, "A Study of the Faunas of the Residual Mississippian of Phelps County (Central Ozark Region), Missouri," *Jour. Geol.*, Vol. XXV (1917), pp. 558-75.

ered out of the basal conglomerates of the Pennsylvanian. In one or two instances, however, there are good reasons for believing that there are small areas of Mississippian rocks which are still in place, and which rest unconformably upon the Jefferson City dolomite (Beekmantown), as do also most of the Pennsylvanian outliers.

A few months ago the junior author discovered a small outlier containing a fauna which is characteristically Middle Devonian in age. This fauna when identified proved to be of sufficient diagnostic value to place the age of the outlier within very narrow

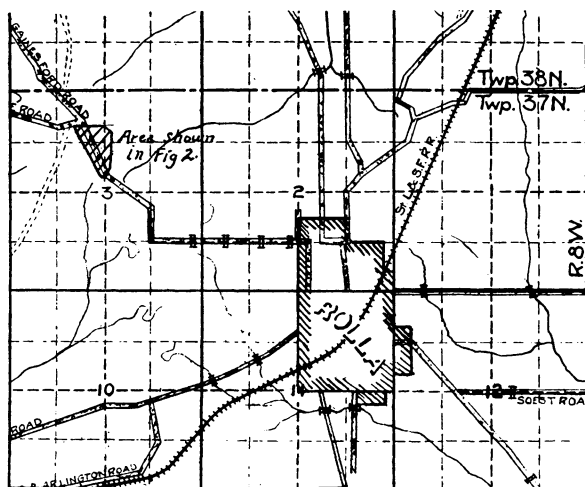


FIG. 1.—Sketch map showing general location of Devonian outlier. The shaded portion represents the area shown in detail in Figure 2.

limits. Inasmuch as Devonian has never before been reported from this area, the finding of this outlier gives a little more light on the history of the uplift, and the purpose of this paper is to describe this occurrence and its fauna, and to add its bit of evidence to the history of the region.

LOCATION AND GENERAL DESCRIPTION

The Devonian outlier lies about $1\frac{1}{2}$ miles northwest of Rolla, in the NE. $\frac{1}{4}$ NW. $\frac{1}{4}$ sec. 3, T. 37 N., R. 8 W. (Fig. 1). It is on the east side of the road and lies fifty feet below the crest of the ridge

(Fig. 2). It occupies a little knoll between two gullies, and when first found consisted of a number of knobs of quartzite projecting from the hill and having a rough alignment. The base was concealed, but just above the top of the outlier were a number of Mississippian boulders, and on the north, west, and south at higher and lower levels are outcrops of the Jefferson City formation¹ (Fig. 2).

The summit of the ridge is capped by a thin stratum of Pennsylvanian sandstone, and boulders of Pennsylvanian float are found in abundance at lower levels. The Pennsylvanian rests unconformably upon the Jefferson City formation on the east side of the hill. On the west side there appears to be a thin stratum of Mississippian between them, but the exposures are very poor, and the exact relationships are difficult to determine. The areal distribution of these rocks is shown on the map² (Fig. 2).

An excavation was made along the side of these quartzite masses in an attempt to expose the lower contact. This was not entirely successful, but the excavation showed that there was a continuous ledge of quartzite at least thirty feet long and from three to six feet in thickness, increasing in thickness toward the east. Beyond the limits of the excavation there are a few other knobs of quartzite, probably continuous with the part just described. This makes the total length of the outlier about fifty feet, and its greatest width slightly less. It is entirely confined to the little nose between the two gullies, and none has been found on neighboring hillsides. Bedding is indistinct, but there are indications of an eastward dip of about 15° . This is regarded as

¹ The Jefferson City beds exposed on this hillside are among the youngest known in this area. They consist of yellow earthy dolomites (cotton rock) interbedded with chert layers, which are often abundantly fossiliferous, a condition not observed in the lower beds of the same formation in the Rolla area. The fossils consist entirely of one or two species of *Hormotoma*, closely allied to *H. artemesia*. It is quite probable that these upper beds belong to the Cotter formation, which overlies the Jefferson City in the southern portion of the uplift, but which has not been recognized in this area. This cannot be definitely stated, however, until the Cotter and its contained fauna are more completely described.

² The writers are greatly indebted to Major C. E. Cooke, professor of topographical engineering in the department of vocational education, and his students, Messrs. Kimball and Hazlewood for making the topographic base for this map.

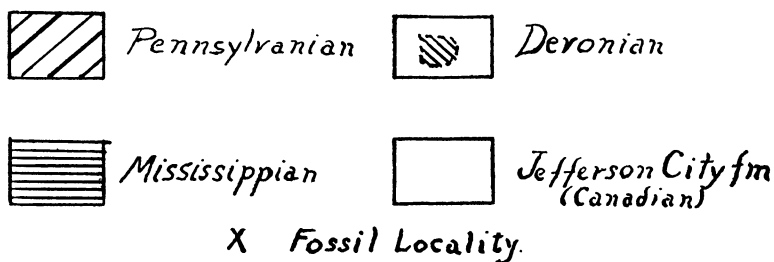
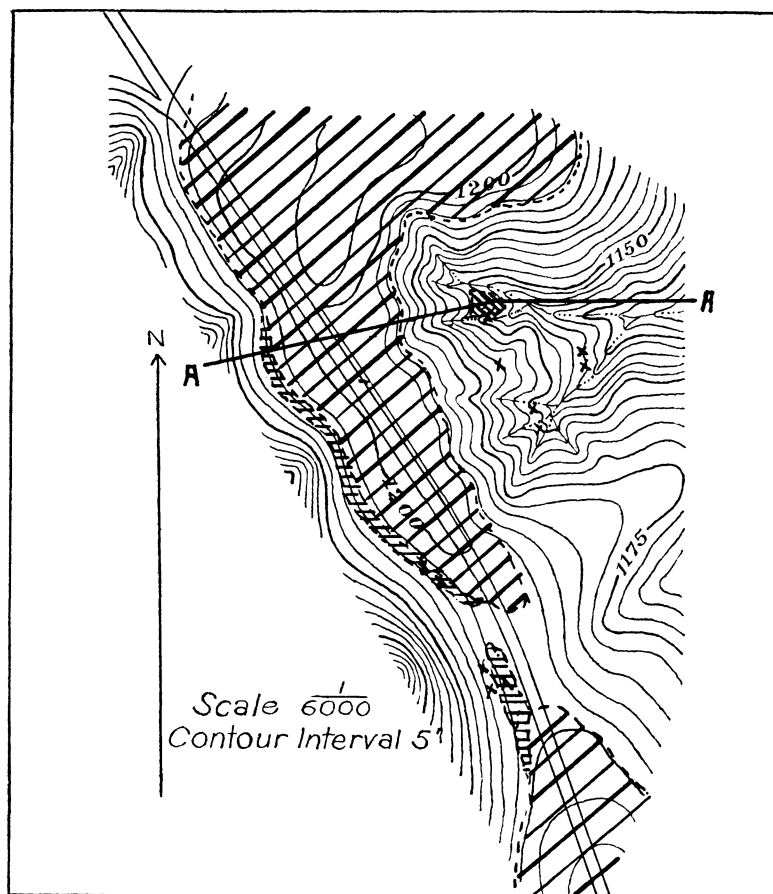


FIG. 2.—Geologic map showing the relationship of the Devonian to the older and younger rocks.

initial dip, and the entire mass appears to rest against an old eastward facing slope developed on the Jefferson City dolomite in a post-Beekmantown pre-Onondaga erosion interval (Fig. 3).

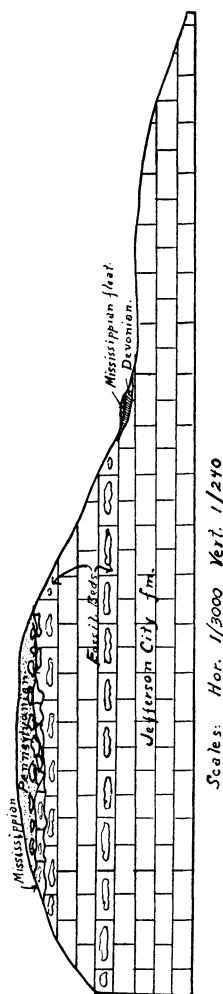


FIG. 3.—Structure section on the line A-A of Figure 2

The Jefferson City formation has been found outcropping to within ten feet of the summit of the hill on the east side and to within fifteen or twenty feet of the summit on the west side. Overlying the Jefferson City beds on the west side is a layer of large boulders containing a typical Burlington fauna. This layer is continuous for several hundred feet, and the boulders are quite large, and it seems altogether probable that they are in place, or that they have not been moved far from their original location. On the east side of the hill this layer is not as prominent, but boulders of Mississippian and Pennsylvanian float are abundant all over the hillside, and some of them rest directly upon the Devonian.

LITHOLOGIC CHARACTERISTICS

Lithologically the Devonian rock is a hard, dense quartzite breaking with a splintery fracture. In color it ranges from white through gray to bluish and almost black. The lighter shades predominate. Thin sections show great numbers of well-rounded quartz nuclei with strong evidences of secondary growth. In some sections the grains show as angular interlocking crystals because of this secondary growth; in other sections, large second-

arily enlarged grains are separated from each other by a finely crystalline ground mass of the same material. The rock contains numerous cavities, most of which have been formed by the leaching out of large fossils, and on the surfaces of these cavities are to be found many small but perfect crystals of quartz and of limonite

pseudomorphous after pyrite. The quartzite is somewhat fractured, and these fractures are filled with a soft, yellow, non-fossiliferous, somewhat conglomeratic sandstone.

From the structure and secondary growth it seems evident that the rock was originally a calcareous sandstone, laid down by an advancing sea against an old land mass. The calcareous matter has been completely leached out, and much of it replaced by silica. The soft, yellow sandstone is of later age, either basal Mississippian or Pennsylvanian.

PALEONTOLOGY

Fossils are abundant in the quartzite. They are not evenly distributed, but are most abundant at the base. At first glance, parts of the stratum appear to be barren, but careful search of almost any fragment will reveal fossils. The fossils all occur as external and internal molds, and in most cases the preservation is excellent. Corals and Mollusca dominate the fauna. Other forms are not common, though individuals of a given species may be very abundant.

The following table gives a list of the species which have been obtained from this quartzite, and also their occurrence at other localities. Column 1 shows species occurring in the Grand Tower formation in southern Illinois; column 2, species occurring in the Jeffersonville beds at Louisville, Kentucky; column 3, species occurring in Michigan; column 4, species occurring in Ohio; and column 5, species occurring in New York.¹

¹ Faunal lists:

1. Illinois: S. Weller, "Correlation of the Devonian Faunas in Southern Illinois," *Jour. Geol.*, Vol. V (1897), pp. 625-35.

T. E. Savage, "The Grand Tower (Onondaga) Formation of Illinois and Its Relation to the Jeffersonville Beds of Indiana," *Trans. Ill. Acad. Sci.*, Vol. III (1910).

2. Indiana, Kentucky: E. M. Kindle, "The Devonian Fossils and Stratigraphy of Indiana," *Ind. Dept. of Geol. and Nat. Res., Twenty-fifth Ann. Rept.* (1900), pp. 529-758.

H. Nettleroth, *Kentucky Fossil Shells*. Monograph, Kentucky Geological Survey, 1889.

W. J. Davis, *Kentucky Fossil Corals*. Monograph, Kentucky Geological Survey, 1885.

3. Michigan: C. Rominger, *Geol. Surv. Mich.*, Vol. III, 1876.

Ohio: F. B. Meek, *Pal. Ohio*, Vol. I, 1873.

H. A. Nicholson, *ibid.*, Vol. II, 1875.

5. New York: James Hall, *Paleontology of New York*, Vol. IV, 1867, and Vol. V, Part II, 1879.

General: Grabau and Shimer, *North American Index Fossils*, 1910.

TABLE I

LIST OF SPECIES IDENTIFIED FROM THE DEVONIAN QUARTZITE AT ROLLA, MISSOURI

	1 Illinois	2 Ken- tucky	3 Mich- igan	4 Ohio	5 New York
Coelenterata:					
<i>Zaphrentis gigantea</i> , Lesueur.....		x	x	x	x
<i>Zaphrentis prolifica</i> , Billings.....		x	x	x	
<i>Zaphrentis</i> Sp.					
<i>Acerularia rugosa</i> (E. and H.).....	x	x	x		
<i>Amplexus yandelli</i> (E. and H.).....	x	x	x		
<i>Favosites winchelli</i> , Rominger.....		x	x		x
<i>Favosites emmonsi</i> , Rominger.....	x	x	x		
<i>Favosites basalticus</i> , Goldfuss.....				x	x
<i>Favosites turbinatus</i> (?) Billings.....		x	x	x	x
<i>Favosites limitaris</i> , Rominger.....		x	x		x
<i>Favosites clausus</i> , Rominger.....		x	x		x
<i>Cladopora labiosa</i> (Billings).....		x	x		x
Molluscoidea:					
<i>Cystodictya gilberti</i> (?) Meek.....	x	H*		x	
<i>Stropheodonta demissa</i> (Conrad).....	x	x	?		x
<i>Rhipidomella vanuxemi</i> , Hall.....	x	x	x	x	x
<i>Centronella glansfagea</i> , Hall.....	x	x	x	x	x
<i>Eunella</i> (?) Sp.....					
<i>Spirifer divaricatus</i> , Hall.....		x		x	x
<i>Spirifer grieri</i> (?) Hall.....	x	x		x	x
<i>Martinia maia</i> (?) (Billings).....				x	
<i>Nucleospira concinna</i> , Hall.....	x	x		x	x
Mollusca:					
<i>Actinodesma occidentale</i> (?) Hall.....	x	x			
<i>Conocardium cuneus</i> (Conrad).....	x	var.		x	x
<i>Conocardium ohioense</i> , Meek.....		x		x	
<i>Bellerophon pelops</i> , Hall.....	x	x		x	x
<i>Bellerophon newberryi</i> , Meek.....				x	?
<i>Hormoloma maia</i> , Hall.....					
<i>Igoceras conicum</i> (Hall).....	x	x		x	x
<i>Loxonema robustum</i> (?) Hall.....				x	
<i>Cyclonema crenulata</i> , Meek.....		x		x	
<i>Callonema bellatula</i> , Hall.....		x	x	x	
<i>Callonema humile</i> , Meek.....		x		x	
<i>Callonema comus</i> , Kindle.....		x			
<i>Tentaculites scalariformis</i> , Hall.....	x	x		x	x
<i>Coleolus tenuicinctum</i> , Hall.....	x			H	H
<i>Orthoceras</i> Sp.....					
<i>Gomphoceras</i> Sp (2).....					
<i>Zittloceras nereus</i> , Hall.....					x
Arthropoda:					
<i>Phacops cristata</i> , Hall.....	x	x			x
<i>Proetus clarus</i> , Hall.....	x	x			
<i>Dalmanites calypso</i> , Hall.....	x	x		x	x

*H indicates that species occurs in the Hamilton at that particular locality.

CORRELATION

From the foregoing table it is evident that this fauna is of Onondaga age, and that it is the partial equivalent of the Grand Tower formation of southern Illinois and southeastern Missouri. Its affinities are entirely with the eastern Devonian and have no resemblance to the later Devonian faunas of Iowa and north central Missouri. Of the thirty-seven identified forms, seventeen occur in the Grand Tower formation of southern Illinois, thirty in the Jeffersonville beds of southern Indiana, thirteen in the Onondaga group of Michigan, twenty-two in the Onondaga of Ohio and eighteen in the Onondaga of New York. These figures are not exact and are probably too low, for the faunal lists from the various regions are incomplete and represent compilations in most cases. The most complete lists are those from the Grand Tower formation and from the Jeffersonville beds. Weller¹ and Savage² have shown the relationship of the Grand Tower fauna to the Onondaga of the eastern United States.

Savage³ has also shown that the Jeffersonville beds are the equivalent of the upper portion of the Grand Tower of Illinois. Since more than 80 per cent of the forms occurring at Rolla are also found in the Jeffersonville beds, it seems certain that this outlier belongs to the upper portion of the Grand Tower formation. In Ste. Genevieve County, Missouri, Weller⁴ assigns over two hundred feet of strata to the Grand Tower formation. Certain horizons in this formation are reported to be full of corals, but until the faunal lists for this formation are completed, a closer correlation cannot be made.

CONCLUSIONS

The presence of a Grand Tower outlier at Rolla indicates a much greater submergence of the Ozark uplift during Onondaga time than has commonly been supposed. The nearest outcrops of the Grand Tower formation are at least 100 miles to the east. The

¹ S. Weller, *loc. cit.*

² T. E. Savage, *loc. cit.*

³ *Ibid.*

⁴ Stuart Weller, unpublished manuscript on Ste. Genevieve County, Missouri, Missouri Bureau of Geology and Mines.

St. Francois Mountains, the structural center of the uplift, are directly between the two exposures, and it is not believed that these were covered in Devonian time. In view of the thinning out of the Devonian to the north, it may be assumed that the Onondaga sea extended westward along the southern border of the St. Francois Mountains, and that it may have covered much of the southern portion of the uplift. Further field work may reveal other outliers, which will enable the boundaries of this sea to be traced more definitely.